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ABSTRACT

A management data base is seen as essential for a management information system, program budgeting, program costing, management by objectives, program evaluation, productivity measures, and accountability in institutions of higher education. The necessity of a management data base is addressed, along with the benefits and limitations it may have for a given institution, and its development, maintenance, and use in both operating systems and management systems. Methods for implementing a data base system are described. Plans for developing a computerized system are also addressed. It is suggested that at the time a data base system is implemented, any existing applications that are not adequate or that need improvements should be redesigned to ensure improved technology in both data entry and retrieval. (LBH)

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Management Data Base Development

by Robert L. Dan

A management data base is essential for a management information system, program budgeting, program costing, management by objectives, program evaluation, productivity measures, and accountability in institutions of higher education. This article comments on the necessity of a management data base, the benefits and limitations it may have for a given institution, and its development, maintenance, and use in both operating systems and management systems.

Definitions

Data Element

The smallest unit of named data in a data base is a data element. A data base consists of a number of data elements, each of which is a unit of data that is complete in itself. A student's social security number is an example. Data elements typically are organized into logically related groups called data records, which in turn usually are organized into logically related groups called data files. A data base is then formed from the logically related groups of data files.

Data Base

A data base may be defined as a centralized collection of nonredundant, detailed, interrelated data elements that can be accessed by all information subsystems in a flexible way to meet the data requirements of all applications.

The use of a data base eliminates the duplication of data elements in data files existing to serve different applications. Further, it insures that data will be maintained in a uniform way, rather than in different formats. It precludes the possibility that one file might be current while another remains static, which is common with the traditional approach in data processing. Finally, a data base is organized in a way that allows data to be used in various applications, thus eliminating the problem of change due to new techniques and devices, and therefore appreciably reducing the overall cost of data processing.

A data base must provide for the integration or sharing of common data. For example, an institution having a system application for student registration may first integrate its data with a system application dealing with billing of students. Subsequently, application data pertaining to revenue accounting by program and department may be integrated. The data in the program of the first two applications need not change when the data of the third application are integrated. The ability to add new elements of data to an existing data base in an evolutionary manner is critical.

A data base also must provide flexibility of data organization. Since all applications may not be written in the same programming language, the data base concept requires that the data and its description be independent of any programming language, of the physical organization of the data, and of the method used to access the data. Data independence and the separation of data description from the restrictions and conventions of any programming language allow centralized data base maintenance, protection, and control over physical aspects of the data base.

A data base must be capable of existing in both batch processing and teleprocessing environments. In batch processing, single transactions are accumulated and processed periodically against the data base. A significant characteristic of batch processing is that of elapsed time. The use of batch processing depends on how current the user data must be in alternate forms of processing. Because the computer data base is not continually available to the batch processing user, the data in the data base may not be up-to-date. That is, the user of the data in a data base maintained by batch processing may not have current information at his or her disposal.

The currency of data within a data base may be improved with teleprocessing. Remote terminals provide the user with the capability to enter transactions as necessary, allowing both inquiry and update of the data base. Data

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bases used for teleprocessing also can be used by batch processing programs for producing reports or answering complex inquiries.

Management Information System

A management information system (MIS) provides meaningful and timely information that assists managers in performing the functions of planning, coordinating, and controlling the operations of an institution. An institution's data base and the data elements comprising the data base provide information to make the MIS function. An MIS assumes the existence of a data base on which operations, conclusions, and decisions can be based. In a computer-based information system, a data base is the set of data that is internally accessible to the computer and on which the computer performs manipulations.

An institution's MIS draws information used in decision making from many sources, most of which can be classified into five major application, or system, areas. These are student, staff, facilities, financial, and curriculum information. Each of these system areas is further subdivided into subsystem application areas, and each of these subsystem areas may be supported by more than one data base. An example is a student information system, with a student registration subsystem drawing on five different data bases. Except for linking elements, each of the data bases represents related elements that are not repeated in the other data bases. For example, the student registration subsystem draws on:

1. Course and section number from course data base.
2. Student biographical data from the student data base.
3. Teacher's name from the staff data base.
4. Building and room number from facilities data base.
5. Tuition and fee rates from the financial data base.

This same relationship between subsystems and the data base files also exists in other applications.

Evaluation of Data Base Approach

Among the advantages of a data base system, as opposed to the traditional approach in data processing, are:

1. Ability to respond more promptly and in a more timely manner to changing and increasing information needs by having a well-organized pool of interrelated data. Demands for accountability are increasing on the part of government agencies and from students and the public, both on a scheduled and on a nonrecurring basis. As institutions change their enrollments, programs, and services, additional information must be maintained and made available to these funding sources. Such demands contribute to a mass of information that management at all levels of an institution must organize, maintain, coordinate, analyze, and distribute. All this requires time that must be taken from the management functions of planning, developing programs, managing personnel, and controlling costs, among other functions.

The ability to respond to requests for information appears to be perceived as "good management" by federal and state agencies, by elected officials, and by the public. The flexible data base approach enables the MIS to provide a quick response to inquiries and may improve the reputation of the institution. A single update of common data instantaneously provides new information for all applications.

2. Reduction of data storage costs by eliminating data redundancy. Data are stored once and are organized to support major application needs. All applications requiring the same data gain access to them by using special data base software. In systems designed without integrated data files, common information must be repeated to support the needs of each application, thereby increasing total storage costs for an installation. A proper balance between data storage costs and processing efficiency should be achieved without going to either extreme.

3. Reduction of program and file maintenance costs. Data organization methods offered in a data base system are more flexible, and programming logic is not tied directly to the data elements.

4. Enhancing of timeliness, validity, and accuracy of data by eliminating duplicate entry. Data elements are entered once rather than separately for each application, thereby cutting processing time and staff cost. One source entry (or document) can effect the update and possibly replace several entries or documents previously required.

5. Ability to take full advantage of advances in computer technology, such as direct access devices for on-line data entry and inquiry.

6. Improved ability to fill management's growing demands for applications that require a data base. Specific programs need to be separate from the data. A desirable objective for data processing and full implementation of the data base approach will occur when an institution's data processing function can respond to any reasonable request by management or external parties for reporting or analysis within a few days and without undue degradation of current routine data processing requirements. A reasonable request would be one that draws on existing computer-readable data.

7. Improved data security in that controls can be built into the system.

8. Elimination of concurrent data update conflicts. Data requests are "scheduled" to avoid uncoordinated update and retrieval of the same physical data.

9. Other technical benefits. These relate to file management software, file structures, "overload" programs, computer operations, and flexibility to make changes in data elements.

There are certain disadvantages and additional costs associated with implementing the data base approach. Among them are:

1. Generally higher computer hardware costs. Additional core storage usually is required in the central processing and random access units to accommodate the larger data base available for update and inquiry and for the more complicated file management software.

2. More complicated software to manage data base files.

3. General lack of experience on the part of data processing staff and users. Staff training programs are essential if members of the institution are to design, use, and maintain the data base system properly.

4. Potentially greater initial application development costs and lead time for implementation due to greater complexity of design. At the same time, however, special data base management software reduces the program coding effort, and having all the data elements available in the data base eases the task of designers.

Necessary Data and How It Is Obtained

Before a decision is made on using the data base approach, each institution should develop its own coordinated plan for the development of its MIS. The parameters and objectives of such a system must be defined and agreed on by senior managers and the data processing professional staff. Operating and management users should be consulted. The decision to utilize the data base approach should be made as a result of the total system planning effort and after evaluation of the benefits, costs, and limitations of the data base approach and of traditional approaches.

At Black Hawk College, a board committee and a citizens' technical advisory committee were utilized in addition to use of internal managers and staff in developing a plan for an MIS. In the design of specific systems and subsystems, staff task forces were used to assist in determination of data elements, inputs, and outputs. Also considered was the work being done on a statewide MIS for the Illinois Community College Board and all the Illinois public community colleges.

Definition and Selection of Data Elements

The best approach to determine the necessary elements for a data base is to study an institution's total activities and discover the data currently in use, the way they are used, and where and how they originate. Information also should be obtained concerning anticipated requirements for data. A study of this type requires the full cooperation of all segments of the organization.

A pragmatic approach to the task of developing a data base is to determine the data in use by the data processing department and how they are being used. If proper documentation has been maintained, such a study can be accomplished fairly rapidly and simply. A data base then can be designed to hold all data now in use, and growth can be allocated for anticipated and unknown future requirements.

To simplify the study and insure uniform results, a data element source and use form is recommended. The first section on the form identifies the data element by its normal name and the name by which it should be referred to in the data processing department and its programs. The same section specifies the size and format of the data, the method used to convert the data into a machine-language document, and the source document from which the data is obtained. Possible alternate sources are indicated, as are the origin of the data and the means by which they are created. The remainder of the form is devoted to the applications and programs in which the data are used.

All lines of the form are valuable in determining the content and use of the data element, as well as future uses. Listing alternate sources of information is helpful, both to the analyst preparing new applications and modifying existing applications and to operations personnel when emergency reconstruction of a data base is required. The information concerning the point of origin and method of creation is especially valuable where teleprocessing is being considered for the future. An analysis of this type will make possible a clear and definite determination of data base content.

Record expansion. The ideal data base contains enough expansion room in each record to satisfy all future information requirements. Although sufficient space could be included in any record format to allow for unlimited future expansion, records of excessive length require expensive additional storage space capacity, tie up input-output channels for longer periods of time, and result in a serious reduction in operating speed. By contrast, if adequate

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expansion is not provided for, the result is early obsolescence, which may require redesign of the data base, the accessing method, and all the computer programs using the data base. A reasonable compromise must be based on two major considerations—the value of existing data and the projection of future information needs. Existence of a device capable of storing all of an organization's data will not solve the problem of determining what the content of the data base should be. Regardless of hardware capabilities, stringent control must be exercised over the data to be permitted in the data base.

Value of historical data. A study of the historical data requirements of an organization may be of benefit in attempting to predict future data requirements. However, past performance does not necessarily determine or have any influence on the needs of future data requirements. In the design of individual data base formats, sufficient space should be provided to project the addition of data elements expected to be required within five years. A five-year period is selected because most data processing requirements are too dynamic to allow for anticipation of more than five years in advance.

Projected information needs. Key persons in user departments may be surveyed for new information requirements expected within the next five years. An alternative is to survey data processing departments of other institutions and find out what their applications are and what information exists for their applications. College and University Systems Exchange (CAUSE) also may be helpful as a source of information on future needs. Another useful source is the OASIS Data Element Dictionaries developed as part of Project INFO by Stanford University. The results of such surveys then can be discussed with the appropriate internal user departments to obtain an idea of future applications and information requirements. Another beneficial tool is the set of data element dictionaries published by the National Center for Higher Education Management Systems (NCHEMS). These data element dictionaries have been developed in the areas of course, facilities, finance, staff, and student, and have been published by NCHEMS as Technical Reports Number 29, 30, 31, 32, and 33.

Accessing the Data Base

Access to the data base can be obtained through either a batch mode or an on-line mode using a direct access device. Use of a specific mode would depend on such factors as frequency of inquiry, inquiry response time, information retrieval, and cost-benefit ratio of storing and accessing the data.

Delays in batch processing are often natural, and little advantage can be obtained by reducing them. But elimination of the necessity for such delays changes the nature of data processing from a passive recorder of history to an active participant in the current operations of an institution. The computer thus interacts with persons on a dynamic basis, obtaining and providing information and recording decisions.

On-line approach. One approach to computer processing that can provide solutions for many information processing problems and also can accommodate the objectives of a data processing master plan is on-line data entry and inquiry. Application designers using this approach make at least two assumptions:

1. There is some kind of terminal such as a cathode ray tube (CRT) at the user's work station connected directly to the computer.
2. All necessary data are available immediately to the computer on large-capacity storage devices.

Inquiry. A display station (CRT) is used with an inquiry application to give the user rapid access to the central computer file. To accomplish inquiry, the operator issues a short input message. The computer then processes this message and gives immediate response to the inquiry message. For example, the operator might issue the following command:

"BIOSKETCH 478-50-1773"

whereupon the computer would display on the CRT a complete and accurate sketch of the student with social security number 478-50-1773. This sketch could include the student's name, address, telephone number, and schedule of classes. This type of inquiry application can be extended to vendor status, employee records, class rosters, section enrollments, etc. Inquiry of this sort provides the user with the information without delay and without the necessity of having such information printed by the computer on a regular basis for all students.

Inquiry with update. To extend the example, the operator may find it necessary to change the student's name or other information after the display is sent to the user's CRT. Change to the record may be made at once, and the changed record submitted for processing. The user need not wait until the next batch is run to receive edit listings for correction.

Data entry. There are many applications in which the user must code information from source documents and submit the coded transactions for subsequent keypunching and processing. If any errors are made in this process, it may be some time before the user is able to take corrective action. By providing capability for on-line data entry, the user may submit a transaction for editing and processing as it occurs. The computer immediately processes the transaction and returns the results to the user. If errors were detected during the edit, the user can either resubmit the transaction or correct the error.

Errata

In "A Cash Management Model," by William W. Boyles (Vol. 7. No. 2, May 1975), Figures 2 and 3 were printed without certain entries being underlined. This editorial error is corrected below (for Figure 2) and on the reverse (for Figure 3). In addition, the following should be substituted for the third sentence of the first full paragraph on page 3: "Using a period of as much as thirty days should produce results wherein the error in the estimate would be negligible."

($ Million)			Beginning Bank Balance	Beginning Book Balance	Balance Produced by Float	Checks Paid by Bank	Deposit (Regular)	Deposit (Extraordinary)	Checks Issued (Regular)	Checks Issued (Extraordinary)	Short-Term Investment	Explanation of Extraordinary Items
Day of the Year	Month	Week	BBB	BKB	BFL	CPD	DEP	DEE	CIS	CIE	INV	EEE
001	1	T	.756	.382	1.138	.360	.458	—	.324	—	.354	
002	2	W	.854	.248	1.102	.726	.469	—	.201	—	.097	
003	3	T	.597	.020	.577	.592	.328	—	.376	—	.267	
004	4	F	.333	.028	.361	.283	.216	1.000	.489	—	.766	Matured Investment
005	5	S	—	—	—	—	—	—	—	—	—	
006	6	S	—	—	—	—	—	—	—	—	—	
007	7	M	1.266	.699	.567	.735	.367	2.820	.604	—	3.218	State Support
008	8	T	3.718	3.282	.436	.242	.482	—	.316	—	3.458	
009	9	W	3.958	3.448	.510	.428	.358	—	.406	—	3.388	
010	10	T	3.888	3.400	.488	.381	.291	—	.316	—	3.298	
011	11	F	3.798	3.375	.423	.361	.489	—	.281	—	3.426	
012	12	S	—	—	—	—	—	—	—	—	—	
013	13	S	—	—	—	—	—	—	—	—	—	
014	14	M	3.926	3.583	.343	.511	.376	—	.534	—	3.291	
015	15	T	3.791	3.425	.366	1.714	.432	—	.386	1.500	2.009	Contractor Payment
016	16	W	2.509	1.971	.538	.421	.387	—	.506	—	1.975	
017	17	T	2.475	1.852	.623	.449	.703	—	.256	—	2.229	
018	18	F	2.729	2.299	.430	.394	.546	—	.489	—	.381	
019	19	S	—	—	—	—	—	—	—	—	—	
020	20	S	—	—	—	—	—	—	—	—	—	
021	21	M	2.881	2.356	.525	1.528	.608	—	.289	.835	1.461	Loan Payment
022	22	T	1.961	1.840	.121	.116	.532	—	.624	—	1 877	
023	23	W	2.377	1.748	.629	.394	.611	—	.473	—	2.034	
024	24	T	2.594	1.886	.708	.530	.455	—	.506	—	2.019	
025	25	F	2.519	1.835	.684	.501	.305	—	.289	—	1.823	
026	26	S	—	—	—	—	—	—	—	—	—	
027	27	S	—	—	—	—	—	—	—	—	—	
028	28	M	2.323	1.851	.472	.640	.448	.250	.516	—	1.881	Insurance Recovery
029	29	T	2.381	2.033	.348	.205	.302	—	.614	—	1.977	
030	30	W	2.477	1.721	.756	.504	.504	.441	—	—	1.977	
031	31	T	2.577	1.784	.693	2.657	.813	—	.122	2.122	.133	Monthly Payroll
032	1	F	.633	.353	.280	.331	.323	—	.211	—	.125	

Figure 2

($ Million)			Beginning Bank Balance	Beginning Book Balance	Balance Produced by Float	Checks Paid by Bank	Deposit (Regular)	Deposit (Extraordinary)	Checks Issued (Regular)	Checks Issued (Extraordinary)	Short-Term Investment	Explanation of Extraordinary Items
Day of the Year	Month	Week	BBB	BKB	BFL	CPD	DEP	DEE	CIS	CIE	INV	EEE
001	1	T	.756	.382	1.138	.360	.458	—	.324	—	.354	
002	2	W	.854	.248	1.102	.726	.469	—	.201	—	.097	
003	3	T	.597	.020	.577	.592	.328	—	.376	—	.267	
004	4	F	.333	.028	.361	1.033	.216	1.000	.489	.750	.016	Short-Term Investment Matured Investment
005	5	S	—	—	—	—	—	—	—	—	—	
006	6	S	—	—	—	—	—	—	—	—	—	
007	7	M	.516	.051	.567	3.985	.367	3.570	.604	3.250	.032	Matured Investment Short-Term Investment State Support
008	8	T	.468	.032	.436	.242	.482	—	.316	—	.208	
009	9	W	.708	.198	.510	.428	.358	—	.406	—	.108	
010	10	T	.608	.150	.488	.381	.291	—	.316	—	.048	
011	11	F	.548	.125	.423	.361	.489	—	.281	—	.176	
012	12	S	—	—	—	—	—	—	—	—	—	
013	13	S	—	—	—	—	—	—	—	—	—	
014	14	M	.676	.333	.343	.511	.376	—	.534	—	.041	
015	15	T	.541	.175	.366	1.714	.432	1.250	.386	1.500	.009	Matured Investment Contractor Payment
016	16	W	.509	.029	.538	.421	.387	—	.506	—	.025	
017	17	T	.475	.148	.623	.449	.703	—	.256	—	.229	
018	18	F	.729	.299	.430	.394	.546	—	.489	—	.381	
019	19	S	—	—	—	—	—	—	—	—	—	
020	20	S	—	—	—	—	—	—	—	—	—	
021	21	M	.881	.356	.525	1.528	.608	.500	.289	.835	.039	Matured Investment Loan Payment
022	22	T	.461	.340	.121	.116	.537	—	.624	.300	.077	Short-Term Investment
023	23	W	.577	.052	.629	.394	.611	—	.473	—	.294	
024	24	T	.794	.086	.708	.530	.455	—	.506	—	.209	
025	25	F	.719	.035	.684	.801	.305	—	.289	—	.023	
026	26	S	—	—	—	—	—	—	—	—	—	
027	27	S	—	—	—	—	—	—	—	—	—	
028	28	M	.523	.051	.472	.640	.448	.250	.516	—	.081	Insurance Recovery
029	29	T	.581	.233	.348	.206	.302	—	.614	—	.177	
030	30	W	.677	.079	.756	.504	.504	—	.441	—	.177	
031	31	T	.677	.016	.693	2.657	.813	1.800	.122	2.122	.133	Matured Investment Monthly Payroll
032	1	F	.633	.353	.280	.331	.323	—	.211	—	.125	

Figure 3

There are many advantages of on-line inquiry and data entry approach over the traditional batch approach:

1. Answers to inquiries can be made immediately with very little clerical effort. A sample question might be: Is Accounting 101, Section 1, closed? If not, how many seats are left?

2. Answers to queries come directly from the central computer files on an as-needed basis, without prior computer operations scheduling.

3. Operator training is easily accomplished, as the CRT components closely resemble a TV screen and a typewriter keyboard.

4. Several persons may use the same information at the same time in different locations without the need of producing several copies of the same report.

5. Input can be edited immediately after it is coded, thus eliminating the lag found in traditional batch processing.

6. Systems can be designed for greater data security. An operator may gain access to information only after supplying a password or key.

Implementation of a Data Base System

Five steps may be taken in evaluating the concept of a data base system.[1]

1. Take the idea seriously. Senior management should provide directions to the data processing manager by identifying key tasks of the institution and setting priorities for an improved capability. An example of this direction is the data processing master plan.

2. Set up a data administration function. The issue is *when* to set up a data administration function, rather than *whether* to have such a function. An administrator ultimately will be needed to implement the data base concept. For those institutions currently without such a position, an administrative structure is needed for formulating a data base implementation plan, regulating the pace of implementation, and establishing data base standards, controls, and access procedures. (At Black Hawk College, this function is assigned to the director of data processing.)

3. Incorporate data base technology into the computer system. Both the hardware and software technology for data bases have matured to the point where the data base concept is feasible and cost-effective for many organizations. While an institution may not be noticeably affected in the short run by ignoring data base technology, it will be affected in the longer run. The data base concept cannot be implemented overnight. Technological improvements should be assimilated into existing systems in a slow and orderly fashion. To incorporate the technology that will permit data base operations, an institution must identify its key computer-based systems and restructure them to remove redundancy and to facilitate their use by higher levels of management.

4. Consider data a resource. For the longer term, managers should begin to think of data as a basic resource. They should accept this idea as a natural consequence of functional specialization of the general management function.

5. Estimate the institution's position in the evolutionary sequence. If the institution is still at a rudimentary stage of development, plans must be made for development. If the college or university is fairly advanced, still more may be accomplished.

Plan for Development of a Computerized MIS

The basic question for many institutional administrators is not whether to implement the data base approach but whether to develop a computerized MIS. Or stated differently, managers need to evaluate the data base approach in the context of developing a master plan for a computerized MIS. Such a plan should consider the following factors:

1. The general objectives the system is expected to accomplish.

2. An analysis of projects and systems currently operational, including problems, inadequacies, and strengths.

3. Identification of alternatives and their effects, including identification of systems, subsystem planning and implementation schedule, cost and other resource implications, benefits, tradeoffs, uncertainties, and priorities.

Redesign of Existing Applications

At the time a data base system is implemented, any existing applications that are not adequate or that need improvements should be redesigned. This will result in improved technology in both data entry and retrieval.

[1] Richard L. Nolan, "Computer Data Bases: The Future Is Now," *Harvard Business Review*, September-October 1973.

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